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Communication advantages of line drawings

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Abstract : This paper investigates the cognitive foundations of a pragmatic account of line drawings. It sets to highlight those features of line drawings that make them, as opposed to other types of visual representations, particularly conducive to communication. It is argued that representational and artifactual properties of drawings must be investigated together in order to understand the peculiarities of drawings as communicative tools.

Keywords: *drawings, artefacts, cognitive bases of drawing, pragmatics, communication, depiction, pictures*

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1. Pictures in communication

The main tenet of pragmatics is that communication through language is not to be reduced to the mere encoding-decoding of the propositional structures of sentences. Sentences are construed as “pointers” used by the speaker in order to activate in the listener mental states whose content is generally much richer than that of the sentence used (Sperber & Wilson, 1986). An alleged reason is that the brain, at the time language appeared, had already rich enough inferential abilities, which rendered useless the sentential translation of information to be communicated. Another alleged reason is that many mental states have no propositional content, for instance because they use an analogical structure (Prinz, 2002). Finally, it is reasonable to think that the urge to communicate is not bound to contents that are expressed in sentences.

In order to communicate about items with no propositional structure, the speaker must either talk and rely on the inferential capabilities of the listener, or use other, non-linguistic means. One of these is pointing the objects to be described. In cases like these, which are plethora, the speaker has no straightforward means for communicating the non-propositional content of her mental states, as the brain has no means of solving the communication problem in the way it did thanks to language modules. And the environment does not support any simple way to communicate in a non-propositional mode (it could have been otherwise: fingertips may have left traces in air.) Images, human made artefacts, provide one such means. Amongst them, drawings are certainly the most important case (Maynard, 2005). In fact, drawing is the oldest way to produce images (the oldest known drawings date 30 000 years back). Until the development of photography, and of digital photography especially, drawings were also the easiest means to produce images. More importantly, and this is the topic of this paper, drawings have a set of peculiarities that made them privileged communicative tools.

In the first part of our paper we investigate such peculiarities by classifying them as inherited from either of two key features of line drawings: their being depictions and their being artefacts. In order to study the depictive side of drawings we will endorse the quite consensual assumption that drawings, as other pictures, can depict because of the way they activate our perceptual and recognitional apparatuses (Gombrich, 1969; Schier, 1986; Lopes, 1996). The artefactual side of drawings has been much less studied (cp. however Maynard 2005). In order to investigate drawings as artefacts, we will propose a novel account, which emphasizes the immediate link drawings have with action; and, as we shall see, some key features of the drawing gesture appear to be immediately accessible to the viewer. In the second part we will jointly assess depictive and artefactual properties of drawings in order to investigate some pragmatic uses of line drawings in communication.

2. Cognitively interesting features of line drawings

This section investigates the properties that give drawings their depictive power, or, in other words, the power to represent things. A note on the methodology is in order here. We shall draw from a corpus of informal data and observations derived from drawing practice and from the study of existing drawings, as well as from established data from experimental psychology.

2.1. Features linked to recognition.

The puzzling feature of line drawings is that they represent objects by using lines (in what follows lines in drawings, whenever necessary, will be

called ‘vehicle lines’) and that at the same time lines in the environment – in particular, those that would correspond to vehicle lines – are almost nowhere to be found. Sure enough, certain visual lines may be alleged to exist in nature, where visual textures become denser (fig. 1).

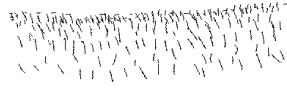


Fig.1 An optical increase in textural density can induce the perception of a line in the environment.

However this is not the general case, as it only works for certain types of surfaces and textures. This being the case, how can drawing represent at all? Indeed:

1) Vehicle lines are not the representation of environmental features that are “line-like” such as mere *illumination* discontinuities. Typically, it is forbidden to represent illumination boundaries in drawings (Cavanagh, 2005; Kennedy, 2003). Illumination discontinuities are just ignored by draughtsmen. No line drawings were ever used to represent cast shadows by tracing their profile (cp. however Kennedy 1974 for evidence that lines can be used to represent the outlines of cast shadows). If traced as lines, illumination discontinuities would make the drawing hard to parse.

2) Vehicle lines are not the representation of environmental features that are “line-like” such as *reflectance* discontinuities that do not correspond to figure/ground discontinuities. This is why black-and-white checkerboards are so poorly represented by line drawings: the strong reflectance discontinuities between two adjacent squares do not correspond to figure ground discontinuities (cp. Kennedy 1974 for a contrary claim about some types of drawing).

Vehicle lines that violate the two rules above become almost uninterpretable. For instance, it is unlikely that the drawings in fig. 2 convey the impression of a shadow cast on a checkerboard. Neither the luminance boundary of the shaded area nor the reflectance boundary between black and white cases is conveniently representable through lines. See Rensink & Cavanagh (2004) for an empirical investigation of these phenomena.

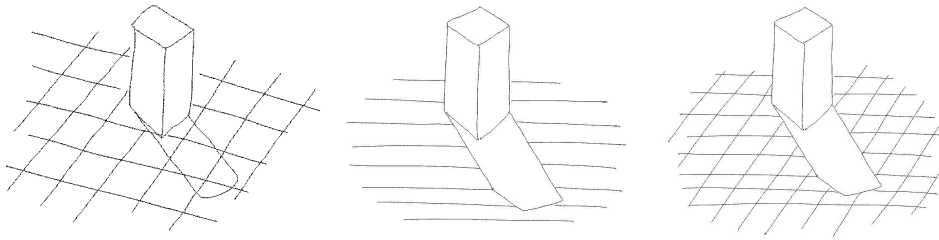


Fig. 2. Lines are semantically constrained. Violations of the semantics of lines make them uninterpretable.

3) By contrast, vehicle lines can represent figure-ground discontinuities that are not reflectance discontinuities. A man dressed in white in front of a white wall may turn out poorly in a photograph, but poses no representational problem to a line drawing.

4) Lines are not the mere highlighting of the visible contours of objects. This is testified by the fact that reliable computer vision algorithms capable to transform a photo into a line drawing are not available, in spite of the fact that extracting contours of objects is something that algorithms do quite well (Casati, 2005; DeCarlo *et al.*, 2003; cp. Pearson *et al.* 1990 for mixed results of ‘cartoon’ algorithms). See fig. 3 for an example of objectively similar shapes that require differential treatment in drawing.

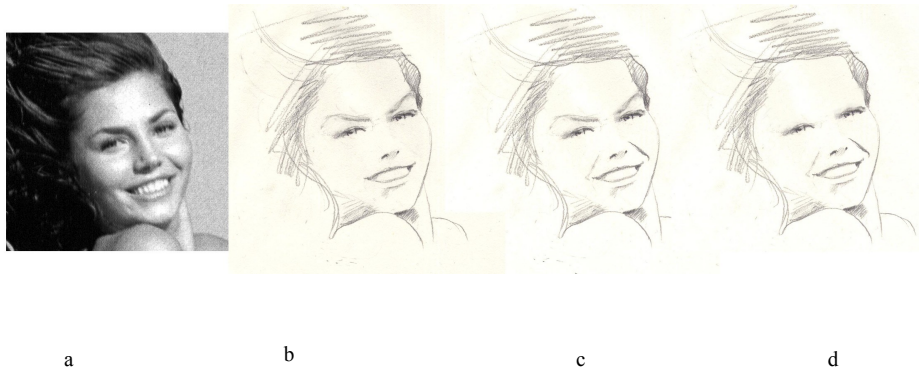


Fig 3. No algorithms could predict that in order to reproduce the face in picture (a), the shadows under the cheeks should be suppressed (compare (b) and (c)) but eyebrows should not (compare (c) and (d)), even if, in terms of luminance, shadows and eyebrows are very similar.

A peel-off test would dictate that if one traces all luminance and reflectance discontinuities, one can then ascertain which ones can be deleted without compromising recognition or parsing, which may even be improved. Low-level algorithms are unlikely to deliver the appropriate mix.

5) Many vehicle lines do not correspond to any visible feature on the object represented by the drawing. For instance, ‘isolines’ or ‘depth-slice’

(as they are called in Maynard, 2005) are used to suggest volume (fig. 4). Notice that the effect of volume is not only due to the shadowing function of such lines (compare the left and right drawings in fig. 4) but to the fact that they follow volume, as if they were surface texture providing local surface orientation information.

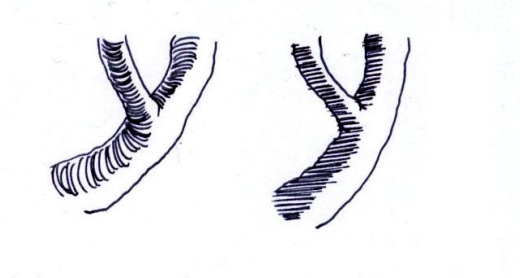


Fig 4: Isolines strengthen the volumetric effect

6) In many drawings, asking what a *particular* vehicle line represents is impossible, because the shapes in the drawings have no equivalent in the real world (e.g. in caricatures, or in very schematic cartoons.)

This kind of considerations about the “unnaturalness” of the vehicle lines leads many authors to consider that vehicle lines are purely conventional. For instance, Ocivirk *et al.* write that “line, as such, does not exist in nature; it is a man-made invention, an abstraction, developed as an agent for the simplification of statements of visual fact and symbolizing graphic ideas” (quoted in Maynard 2005, p. 99.) However, saying that vehicle lines are just conventional symbols like letters would be as implausible as the assertion that there is a one-to-one relation between the aspect of a kind of line and the aspect of a kind of object. A basic empirical argument to reject the conventionalist theory is that children, stoneage tribesmen and even monkeys seem to interpret line drawings more or less as human adults do (Cavanagh, 2005.)

A more plausible, and now quite consensual, position is that vehicle lines are “natural” in that they activate our perceptual apparatus, at some stage of information processing, as would the object represented by such line when seen in a real-life encounter (an idea introduced by Gombrich, 1969.)

For instance, Cavanagh’s (1999) formulation of the point is that the mid-level code used by the visual system for representing three-dimensional objects uses a format that is compatible with the format used by line drawings. If this is the case, then draughtsmen are simply tapping into that code when representing an object via certain lines. It is as if the first stages of vision are sidestepped by the draughtsman whose production directly

solicits the intermediary stage of the visual system. In other words, at some stage of perception the processing of vehicle line matches with real world properties processing. If that is true, the “matching point” must be located at a quite high level of abstraction.

In fact, point (5) shows that vehicle lines can represent volumes despite the fact that there is objectively no resemblance at all between the aspect of the volume and the aspect of the line. More dramatically, point (6) shows the impressive level of deformation that line drawings can support while being perfectly legible, even by children (Johnson, 2005.) Thus, if the “matching point” postulated by Cavanagh exists, it must be abstract enough so as to allow to process the lines of fig. 4 as if they were a volume, and the lines of schematic and deformed cartoons as representing objects. In line with this:

7) Completely negative line drawings (white lines on black background) are perfectly readable, indicating a level of abstraction of the internal code in which the elementary light/darkness opposition is not relevant. The same does not hold for photographs.

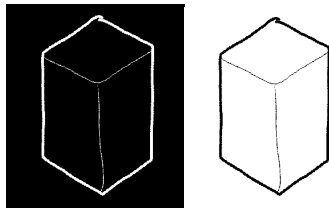


Fig. 5. Negative drawings are as readable as their positive counterparts.

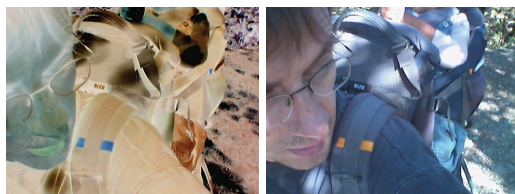


Fig. 6. Negative photographs are less readable than their positive counterparts. In negative pictures (left), colour constancy is impaired, light spots become spots tout court, shadows are unreadable.

Thus, photographs seem to match real world processing at a lower level of abstraction than drawings do, a level where positive and negative colours are processed differently.

To sum up the progress made so far: the visual processing of line drawings matches real world processing at a level of abstraction which is intermediate between:

- a purely conceptual level, as in the case of the matching between the processing of the word “mouse” and the perception of a real mouse.
- a low level perceptual stage, where luminance, colours and textures are processed in a purely analogical fashion (Marr, 1982.)

The hypothesis of such “mid-level” matching point explains why it is so hard to directly deduce, by looking at an object, how to draw it. Indeed, in order to “convincingly” draw objects, draughtsmen had to discover slowly, by trial and error, the graphic tools capable to successfully activate the mid-level code used by our perceptual apparatus. This also opens some nontrivial possibilities, some of which are listed in the following remarks. The first set of remarks (points 8 through 14) concerns the ‘ecology’ of vehicle lines, that is, the representational properties of vehicle lines that operate at a pre-recognitional level. The second set (15 and 16) concerns the recognition of the drawing as whole, as representing an object.

8) Line selection reflects *modal* (in the sense of being related to alternative possibilities) properties of representation. Contour lines, i.e. lines that separate figure from background, are not the only ones to appear in drawings. Some lines are internal to the figure. Typically (barring lines that belong to the surface), these are lines that *would* become contour lines *were* the figure seen from a different (specific) viewpoint. Consider a face depicted quasi-frontally. A line corresponding to the profile of the nose is totally contained within the face’s profile. However, *had* the sitter turned her head a bit more, the nose-line *would have* separated figure from ground. In this sense some lines express non actualised possibilities of the visual exploration of an object.

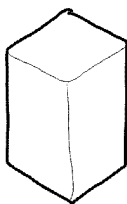


Fig. 7. Some lines that do not correspond to profile lines are recorded on drawings, but in the norm they signal edges that can become parallax sensitive – so that they would divide figure from ground had the object been appropriately turned. Here light grey lines would turn into parallax sensitive boundaries if the object is turned about 45° on its base.

9) In technical drawings some conventions reinforce this division of labour among lines. Figure-ground terminators are thicker than within-figure terminators. On this account, line drawings are well-suited to represent some aspects of parthood articulation of objects. The cognitive saliency of some parts is a consequence of the possibility for them to offer a profile to the viewer, had the object been disassembled into its constituent parts.

10) Generalizing out of this observation, vehicle lines in drawings are *hierarchically organized*. They can first and foremost indicate parallax-sensitive profiles, i.e. profiles in which visual flow in the image is expected to display a steep gradient (fig. 8.)



Fig. 8. The first interpretation of a vehicle line is that of a parallax-sensitive profile.

To this category belong figure-ground profiles. These can be of at least three types. First, object profiles belong to individual objects (fig. 7.)

Second, a “flight” profile belongs to a collection of objects which are close enough to each other to induce a near equivalent visual flow, and are distant enough from background objects to induce a visual flow that is different from that of the background (fig. 9.)

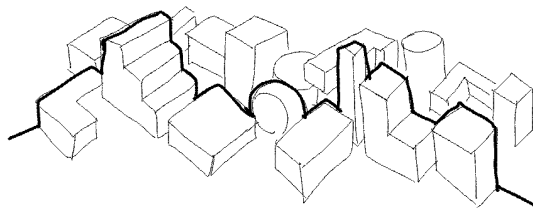


Fig. 9. Flights of objects are clearly separated by lines.

Third, beyond a certain distance, or against very distant backgrounds such as the sky, the relative closeness of a flight of objects loses relevance (this is the case of faraway landscape profiles, fig. 10.)



Fig. 10. Faraway profiles merge different parallax-sensitive profiles.

In the above examples, hierarchy is suggested by the relative strength of the lines. Lighter lines are meant to be one step down in the hierarchy than heavy lines.

11) Hierarchy is instrumental in parsing the 3d-structure and object articulation represented in drawings. In fig. 11, the interpretation is as of two superposed cubes. The middle “v”-shaped line is interpreted as a boundary dividing two objects, and not, for instance, as a surface mark. Note that lines denoting cracks would belong to a somewhat intermediate category.

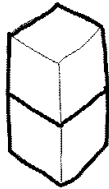


Fig. 11. Two superposed cubes are signalled by the relative thickness of the lines. The middle v-shaped internal line is higher up in the hierarchy than the middle y-shaped internal line because it signals an independent object.

12) Altering the relative strengths makes the drawing harder to parse.

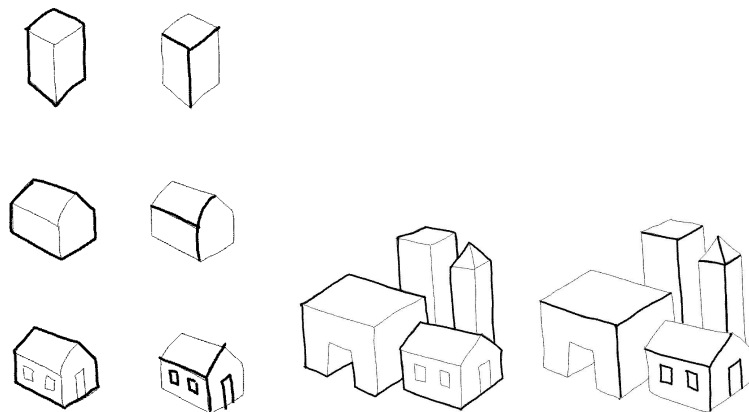


Fig. 12. Drawings in the right column are less easy to parse than those in the left column. Inserting these in a larger drawing further increases the parsing difficulty.

It is to be noted that hierarchies need not be conveyed through relative thickness. Deleting part of the area on the side of the background is another means (fig 13.), one that bears witness to the fact that the internal code for boundaries presents parallax sensitive boundaries as *oriented* (Jackendoff 1991.)

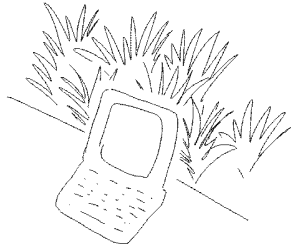


Fig. 13. Deleting visual information on one side of a given boundary raises it up in the hierarchy.

Indeed, new digital rendering techniques allow drawing from background to foreground (one first draws the background, then deletes the relevant areas of the foreground, and iterates the process), something that was impractical or near impossible with paper and pencil. However, it is not as much important *what* particular means (e.g. thickness, strength or deletion) vehicle lines use to convey hierarchy. Rather, what matters is the fact that some type of hierarchy can be conveyed, thereby indicating that the internal code allows for it.

13) Relative thickness or strength of lines can also indicate relations of illumination (lighter lines being interpreted as representing part of the object that receive more light) or distance (lighter lines being interpreted as representing more distant objects.)



Fig. 14. Distance and illumination are conveyed by line thickness.

Notice that this principle is orthogonal with the one of point 12, as ‘more important’ lines from the viewpoint of segmentation can represent

faraway contours or contours which receive more light than less important ones. The task of the draughtsman is to make compromises between the different properties that can be denoted by the strength of a particular line.

14) A higher level hierarchy concerns *portions* of vehicle lines: deleting junctions in line drawings impairs recognition more than deleting lines connecting junctions (Biederman, 1987; see Kennedy *et al.* 2003 for a critique.)

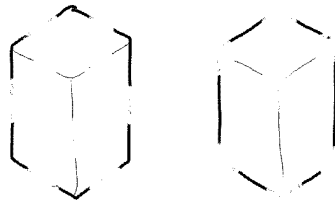


Fig. 15. Recognition is facilitated in the left figure, hindered in the right figure.

So far we talked about properties of vehicle lines that could be grounded in features of the environment, and hence matter for drawings at a pre-recognitional level. The following points describe instead some representational properties of drawing that operate at the recognitional level.

15) Drawings delete much visual information, such as information regarding texture and colours.

16) Drawings often strongly distort the visual information that they keep. Axonometric perspective used in architecture and most directive pictures represent scenes as if they were seen from an impossible viewpoint (Lopes, 2004.) In Manga cartoons the size of some parts such as eyes are exaggerated. Some Picasso drawings and some middle-age engineering drawings mix different viewpoints of the same object. Finally, cartoons or drawings in books for children transform visual information so strongly that it is near impossible to verbally describe the kind of transformations by making reference to the object represented by the drawing.

What is notable is that despite these transformations, drawings are perfectly recognizable, even by children. More importantly, the kind of drawings discussed in point (16) are not perceived as representations of distorted, split or transformed objects. Mangas are perceived as Mangas, Picasso's drawings or middle-age engineering drawings are perceived as representing whole and geometrically 'normal' objects. We do not 'feel' the distortions, splits or transformations. This appears to be specific to drawing. In *paintings* by Bacon we have the impression of seeing a strongly distorted object. In photomontages showing different parts of the same object (such as

those created by David Hockney) we have the impression of seeing a split object. This peculiarity of drawings could be due to point (15): the absence of texture information blocks some forms of binding based on texture (Leder & Bruce, 2000), which makes most distortions, incongruities and transformations go unperceived.

2.2 Features linked to the production process.

The previous section has indicated that drawings have a large set of interesting features that they inherit from the structure and the functioning of our visual and recognitional apparatuses. These may be called the ‘depictive’ features of drawings. This section studies another set of features orthogonal to recognition, namely features that are linked to the *artefactual* nature of drawings, more precisely, features that are linked to the *perception of the result of the production process* of drawings. Vehicle lines – by means of local parameters such as their curvature, thickness, orientation or granularity – keep some perceivable traces of the dynamics of their production, such as the direction of the movement (Freyd, 1983), the speed (Viviani & Stucchi, 1992) and the order in which some related lines have been drawn (Flores d’Arcais, 1994.) Moreover, many people know how to draw lines, if only because they know how to use a pencil and to write; hence for many observers the aspect of a line is connected with action. These two facts combined make it possible to *perceive* drawings *as artefacts*, that is, as the result of the actions of an intentional agent (Pignocchi, forthcoming.) Arguably, this kind of perception is closely linked to the motor system of the observer, and could involve a motor simulation of some dynamic properties of what have been the gestures of the draughtsman (Freedberg & Gallese, 2007; cp. Casati & Pignocchi, 2007). On this account drawings are a quite idiosyncratic kind of picture. Photography and digital images typically keep no perceptual trace of the gesture of their makers (bar some specific ways of taking long-exposed pictures with a moving camera.) This does not mean that the perception of some photographs or digital images cannot activate the motor system of the observer, or be linked in some way with action; the perception of a photograph of a mug, for instance, activates some patterns of actions that can be directed towards mugs, such as grasping gestures. However this type of activation is not relevant here. What is special to drawings is that we can perceive some patterns of the actions involved in the *production process* of the drawing. Thus, the actions of the draughtsman – by means of their direct causal impact on the aspect of the lines such as r curvature, thickness, orientation or granularity – can shape our perception the drawing independently of what it represents.

Three remarks follow:

1) Because of the direct perceptual link that exists between the aspect of lines and the production of a drawing, drawings can be *perceived as artefacts*. This is to be distinguished from *knowing* that what we are looking at is an artefact (as it happens in the case of photography.)

2) The perception of a drawing as an artefact is mandated by the local aspect of the lines. This perception being independent of what the drawing represents, drawings can be – theoretically at least – perceived in two independent ways: as artefacts *and* as depictions.

3) Perceiving the actions of an agent is generally considered a sufficient cue to understand some of the agent's intentions (Gallese & Goldman 1998.) Thus, if we are right in postulating that by perceiving the lines of a drawing we genuinely perceive something about the draughtsman's actions, lines give us a perceptual access to some of the intentions of the draughtsman.

In this section we postulated that we can perceive drawings 'as artefacts', i.e. that there is a perceptual link between some local attributes of the line and the gesture – and maybe the intentions – of the draughtsman. Now, we have to describe how artifactual aspects of drawings interact with their representational properties (described in the first section) so to turn drawings into effective communicative tools.

3. Uses of drawings

To understand the uses of drawings as communicative tools, we propose now to jointly consider the properties of drawings that bestow upon them depictive character and those that bestow upon them artefact character. As artefacts, drawings are things made with the intention to make something for a purpose, that is, with a function. One of the possible functions of drawings – the one which interests us in this section – is to communicate information in a visual format (although they may have other functions, decorative for instance.) To achieve this communicative goal, draughtsmen use the depictive properties described in the first part of this paper. Because of the overarching influence of the communicative intentions of the draughtsmen, those properties acquire their own communicative power, and thereby become a *depictive vocabulary*. On top of the idiosyncrasies of their depictive properties, drawings have another peculiarity, described in the second section above, i.e. the fact that they bear perceptual traces of the drawing act, and by this means they provide the observer a perceptual contact with some of the intentions of the draughtsman. Vehicle lines are at the same time a depictive vocabulary and the perceptual traces of intentions.

Drawings are used for a variety of communication tasks, but if the choice of drawings for visual communication is to be considered more than a historical accident, it must be shown how it is linked to some facts about the functioning of the visual system under the constraints dictated by the communication process. Ideally, such a study would be comparative, as it would pit drawings against other (visual and non visual) information vehicles. The proper methodology here would be to assess these relative advantages of information vehicles on a series of communication tasks. In such a study, relevant parameters would include economy of expression, inferential power, ease of information retrieval, ease of storage in long-term memory. Any comparison should take into account the fact that visual vehicles (photographs and drawings alike, for instance) are intrinsically *spatial* and thus organize information in a specific way.

Given the very general profile of the present study, one should not even limit oneself to commonly used media – as we shall see, mixed media such as superpositions of drawings to photographs could be very effective as they combine some of the relative advantages of the two vehicles. (This technique is indeed used in some technical drawings. We claim that it works poorly if lines violate semantic constraints: internal lines, shadows, etc.)

The exploratory scope of our study does not allow us to delve into most of these issues. At a first blush, in view of the peculiarities of drawings as final products, and of drawing as a motor process, some specific uses of

drawings can be envisioned. In what follows we make an overarching distinction between *static* and *dynamic* uses, that is, uses in which communication is based on the display and observation of the final product (a static drawing) and uses in which communication is based on the display and observation of the drawing process, respectively. It is to be noted that the dynamic use is not to be confused with the perception of some aspects of the gesture which can be “seen” – as assumed in last section – in the static display of the finished drawing.

3.1. Static uses

Drawings are not like motion pictures; vehicle lines do not move. Drawings share this representational poverty with other media, and, like them, they appear to be obviously best fit for representing static objects rather than objects involved in dynamic situations (although in some cases static images are quite good in conveying movement, cp. Gombrich 1969). Within the class of static media, however, drawings have a rich set of distinguishing features – the ones we listed before being the key examples. Given these features, drawings appear to offer interesting uses.

The main class of uses concerns various way drawings can help out recognition. Indeed, in spite of their apparent poverty, they do not in general hinder but rather facilitate recognition.

1) Recognition shortcuts

The cognitive facts linked to recognition suggest that drawings provide essentially *recognition shortcuts*, at various levels, and have thus specific (relative) advantages over other types of visual and non-visual display of information. If drawings sidestep the first phases of visual processing (as per Cavanagh’s hypothesis) they can be used for a quicker access to the relevant information for object recognition, i.e. the restitution of solid shape. By the same token, they can induce a sort of “image oblivion”, that is to say, they skip the phase of abstracting from the visual image by deleting irrelevant details. To this purpose drawings are used in notices and animated cartoons. In comparison with a photo, a drawing can extract relevant information needed in a recognition task, sidestep the first stages of perception, and thus diminish recognition costs (Fraise & Elkin, 1963; Ryan & Schwartz, 1956.) Notice that this effect is not found for individual faces representation: drawn portraits are generally longer to recognize than portraits in photos. One hypothesis is that for faces, textural information is needed for certain forms of binding, without which essential configural information is lost (Leder & Bruce, 2000.)

2) Legibility enhancement

Feature (11) suggests that drawings can outsmart other less abstract types of image when it comes to conveying parthood articulation. The natural hierarchy of parts and sub-parts can be hinted at by different devices such as relative line thickness.

Moreover, drawings can show the different parts of an object each under its most relevant profile, even in case the corresponding viewpoints are geometrically incongruous, and keep at the same time the unity of the overall percept (a possibility that is unavailable with more realistic types of image.) Here the fact that some of the perceptual features (texture, shading) are wiped out from drawings may reduce the load of expectations on other perceptual aspects (such as overall coherence.)

3) Recognition enhancement

Recognition can be enhanced in a number of ways. The first pertains to features of the profile. View point dependency appears to be a well-established fact of object recognition (Tarr & Bülthoff, 1998; the explanation of the fact is however not uncontroversial.) Some objects are more easily recognized under specific view points; for instance, the image of a horse as seen from the side will induce faster recognition than the image of a horse as seen from above. Drawing practice appears to endorse this comparative advantage. A possible explanation is that the salience of parallax-sensitive profiles plays a role in recognition; some profiles are informationally richer than others. This is in general evident with profiled figures – such as shadows – where interior details are unavailable.

In the same vein, drawings are particularly suited to stressing other lines that are used for recognition. In caricatures the metric distortion of the depicted characters does not hinder recognition precisely because the features that are made more salient through the distortion are those that facilitate recognition (representations of parts such as eyes, nose; Kennedy, 1974.) In other words, a drawing can distort visual information so as to enhance the internal representation of the object depicted and to produce what some theorists call “hyperstimuli” (Ramachandran, 1999), that is, stimuli whose features have been altered relative to a geometrically correct representation in order to specifically solicit some modules. Two key examples are recognitional hyperstimuli (i.e. caricatures, Rhodes *et al.*, 1987, and (next section) emotional hyperstimuli.

4) Emotional impact enhancement

Not only recognition can be enhanced in hyperstimuli; some object features convey emotional responses and drawings can make them salient in a dramatic way. The emotional impact of Mangas (and, in a high art

example, of Schiele's drawings) is achieved by exaggerating the emotion-recognition relevant features, such as the eyes, and in general the bodily attitudes and facial expressions which are relevant for the perception of a person's emotional state.

- 5) Making visual information explicit, so as to improve acquaintance with familiar or novel objects

As we observed in section 2.2, the perception of a drawing as an artefact is attuned to the draughtsman's intentions. By looking at a drawing one can readily access the fact that the draughtsman wanted to insist on such and such aspect for such and such reasons; i.e., that there was an explicit intention to bring about a certain visual effect (this explains why preliminary sketches can enrich our perception of the final canvas – even if they are just scribbles if compared to the final product.)

One can set an analogy with intonation and stress in speech. In an utterance intonation can drive attention to a particular word which may otherwise have escaped attention. The speaker flags her intention to drive attention on that specific word, and gives it a particular status in the final interpretation of the sentence. Analogously, the draughtsman can attract attention on a particular shape within her drawing, through the type of movements she used to represent that shape, thereby bestowing on it a particular status in the perception and interpretation of that drawing. Stress phenomena interface the hierarchical structure of vehicle lines. Raising a line in the hierarchy is seen as a reinforcement of the line, hence as evidence of the intention to reinforce it.

One consequence is that – thanks to the motor information contained in vehicle lines – attention can be directed on some shapes independently of what these shapes represent. Without such a device, certain visual features of objects would go unnoticed – as they go unnoticed in the case of the perception of real objects. Take the analogy with speech again. Without specific intonation or specific attention from the listener, the normal case is that the overall meaning of a sentence is understood, without awareness of the vehicle, i.e. the specific words and syntax. Perception of pictures – such as perception of real objects – does the same. We access the identity of the object without caring about its particular shape, which is processed sub-personally. Drawings are pictures with intonation on shapes. The special awareness which drawings give us about some shapes is then passed on to real world perception. For instance, sketches of a human face or body help us seeing those entities better, that is, with explicit visual knowledge and more sensitivity to certain details (Maynard, 2005.)

- 6) Create new percepts

Drawings do not represent – not realistically at least – texture information. As we have seen, this has an impact on the early functioning of our visual system. As said above, the core impact could be the blockage of a form of binding based on textural information, which opens a number of possibilities. Many views of the same object can be combined in a single representational vehicle (as in some Middle Age engineering drawings or in many modern directive drawings), shapes can be distorted in various directions to enhance recognition (or, on the contrary, to slow it down), to enhance emotional impact, to perturb the natural functioning of our attentional routines with novel shapes or accentuated drawing gestures, etc. In the artistic domain, all these possibilities are generally merged in one single drawing (the work by Picasso being probably paradigmatic, although the exploration of drawing licences is much older than that.) What is specific of drawings is that despite the less than photorealistic rendering, they are still experienced as representations of a single (contrary to Hockney photomontages), undistorted (contrary to Bacon paintings) object. Drawings have the power to create totally new percepts that are however unitary.

As a corollary, drawings can be used to represent impossible entities that nevertheless optimally activate the recognitional apparatus, in particular by independently activating different elements of the recognition process. For instance, by presenting the profile of a head and at the same time a frontal view of the eyes, two independent recognitional modules are independently solicited, and information concerning each of them is optimised.

In this respect, some paths could be explored here as to the functioning of the binding process whereby information treated in different channels is recombined in a unitary percept (Triesman, 1982.) Arguably, tolerance for relatively less-than photorealistic representations loosens the constraints on binding, so that in the case of drawings it is easier to bind together potentially discordant stimuli. Texture would act as a “glue”: in the absence of texture there is no integration between the different components, and as a consequence incoherence is not perceived. The benchmark here is the use of photomontage or digital editing techniques for photographs. If a digitally re-mastered photo fuses two types of view of a source object (e.g. a frontal and a side view of a face or of an animal), the result will be likely perceived as the representation of a chimera; whereas a similar combination of two drawings will deliver the representation of the source object. The topic is however relatively speculative as data are forthcoming yet.

6) Enhance communicational features of other media

Given the intrinsic powers of drawings, and their unobtrusiveness (lines take up, after all, a very little share of the whole surface of the drawing), it is possible to superpose them spatially to other media such as photographs, so

as to optimize the saliency of information provided by each medium. In the case of drawings superposed to photographs, line-related information bonuses are paired with surface-related bonuses, and the combined result may be superior to that obtained by each medium (e.g. lines used to characterize surfaces in drawings would seriously compete with profile lines, something that does not happen with the photographic rendering of surfaces.)

Finally, it is to be noted that drawings can also *hinder* communication because of some of their representational *disadvantages*. Absence of textured surfaces and colored surfaces, and the impossibility of realistically representing shadows and same-surface reflectance boundaries, limit the possibilities of drawings.

3.2. Dynamic (processual) uses

This section will briefly hint at the main aspect of a non-static use of drawings. (As we remarked earlier, these uses are not to be conflated with the retrieval of dynamic information from the static surface of a drawing.) Drawings are not produced in a single, instantaneous event – the way photographs are. Each single line in a drawing is the result of the unfolding of an action in time. Thus drawings can be used in cases in which the communicative stress is expected to fall on temporal or dynamic aspects of the entity – typically an event – that is the subject-matter of the communication.

The key instance of this type of use is the practice of drawing directions, in which the temporal unfolding of the drawing process mimics the temporal unfolding of the steps to be accomplished to get to a certain place. A simple prediction here is that in drawing directions people will systematically start from the representation of the current location and end at the representation of the target location. The prediction will lose its air of triviality if it will be possible to show that this is not under all circumstances the optimal strategy (it may turn out that having a good notion of the target location better prepares an understanding of the journey there.)

4. Conclusions and future work

The present contribution is a preliminary exploration of the communication advantages of drawings. In this paper we listed a number of uses of drawings whose *raison d'être* flows from some of their cognitive features. Not all uses of drawings have been listed here, and other reasons for using drawings (e.g. sheer tradition) have not been taken into account here. Our strategy has been to highlight a class of uses for which some of the key cognitive features of drawings are particularly relevant.

It is important to note that the features of vehicle lines that are considered here as conducive to particular uses are not conventional ones; or, if they appear to be conventional, then the convention is deeply grounded on cognitive aspects of drawings. For instance, when discussing how a hierarchy of lines is expressed through relative thickness (the thicker the line, the higher in the hierarchy) we stressed the fact that other graphic devices (such as deletion at one side of the boundary) could play the role of thickness. Conventionality, in such a case, is an irrelevant aspect of the possibility of using drawings.

The present contribution is preliminary in the sense that some of the aspects we claim to have uncovered should be confirmed by empirical data. In that sense we hope to have provided at least the indications for some experimental designs.

The potential interest of exploring uses of drawings according to the present approach lays in the feedback that such an analysis can provide to the study of the cognitive underpinnings of the drawing activity. These are so far relatively poorly understood. It is known that a certain internal code must be directly accessed during the observation of drawings, but the specifics of the code, as well as the way it could be accessed by other modules or systems – e.g. those involved in producing drawings by tracing lines – are still in need of an explanation. Interfacing drawing activities with the requirement of effective communication could provide other, useful constraints to analyze this activity.

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